

CHAPTER 4. Alternative Calculation Method (ACM) Compliance Documentation

Each ACM vendor is required to publish a compliance supplement to their normal program user's manual, or an independent user's manual in which relevant compliance information is easily located and clearly presented. The purpose of this required document is to facilitate compliance with the Standards and the use of the ACM for compliance purposes. This document must deal with compliance procedures and user inputs to the ACM rather than the internal workings and assumptions of the ACM that the ACM uses to determine budgets or compliance. Both the ACM and its compliance documentation must positively contribute to the user's ability and desire to comply with the Standards and to the enforcement agency's ease of verifying compliance. The ACM Compliance Documentation should minimize or reduce confusion and clarify compliance applications. The Commission may reject an ACM whose ACM Compliance Documentation does not serve to meet these objectives. All further references in this chapter to the "ACM Compliance Documentation" refer to the ACM Compliance Supplement or the ACM Compliance User's Manual.

4.1 Overview

The ACM Compliance Documentation must describe the specific procedures for using the ACM for compliance with the Energy Efficiency Standards for Nonresidential Buildings. The ACM Compliance Documentation must provide instructions for preparing the building input, using the correct inputs and using each of the optional capabilities (or exceptional methods) for which the ACM is approved. Also included are procedures for generating the standard reports and related documentation. A sample of a properly documented building analysis must be included.

The ACM Compliance Documentation serves two major purposes:

- It helps building permit applicants and others use the ACM correctly, and guides them in preparing complete documentation for compliance submittals.
- It helps building department staff plan check permit applications for compliance with the nonresidential standards.

The ACM Compliance Documentation serves as a crucial performance method reference in resolving questions concerning specific ACM program attributes, approved modeling capabilities and procedures in the context of both compliance and enforcement.

The Commission actively discourages vendors and applicants from describing the internal algorithms and assumptions and giving information that is not essential to the user to comply with the standards or to resolve compliance-related issues regarding ACM inputs. Once an ACM has been approved, users may not modify or manipulate many aspects that the ACM's calculational engine normally allows users to modify.

ACM users or vendors may disagree with the restrictions, assumptions, and limitations required for an ACM to be approved. However, the proper forum for debate regarding custom budget procedures and the details of the reference method is Commission workshops and hearings on the ACM Approval process and future revisions to this manual, not the front desk of the local enforcement agency or the pages of the ACM Compliance Documentation. For example, the schedules used by the ACM may not be altered by the user and the schedules should not be described in the ACM compliance document. In a similar manner, the ACM Compliance Documentation should not report or describe information that is not directly related to ACM user inputs and required outputs needed for compliance or information needed to clarify questions about ACM user inputs for compliance-related issues.

4.2 Modeling Guidelines and Input References

The ACM Compliance Documentation must contain a chapter or section on how to model buildings for compliance and how to prepare a building input file for a compliance run. Topics shall include:

- What surfaces to model (exterior, interior floors, etc.);
- How to enter data about these surfaces;
- How to model exterior shading (fins, overhangs, etc.);
- Appropriate zoning for compliance modeling;
- Selection of correct occupancy types;
- How to model like systems;
- How to model buildings or portions of a building with no heating or cooling;
- Requirements for written justification and additional documentation on the plans and in the specifications for items on the PERF-1 Exceptional Conditions Checklist;
- Correct use of the standard design modifiers including tailored lighting allotment, and display perimeter if the ACM results are modified by these user inputs;
- Program modeling limitations; and
- The *Nonresidential Manual* as required reading.

All program capabilities should be described in sufficient detail to eliminate possible confusion as to their appropriate use. While references to the ACM's regular users manual are acceptable, a complete listing of all inputs and/or commands necessary for compliance should be included in the ACM Compliance Documentation. The following compliance issues should be explained in the ACM Compliance Documentation or user's manual of each ACM.

4.3 Required Modeling Capabilities

4.3.1 Required Compliance Capabilities

4.3.1.1 Format

Description: The ACM Compliance Documentation must be written in a clear and concise manner. The suggested format is:

- An introduction or overview explaining the use of the ACM for compliance with the Energy Efficiency Standards for Nonresidential Buildings.
- A chapter or section which covers every input that can be used for compliance analysis.

- A chapter or section which covers each standard form or relevant report.
- Appendices, as needed, to provide any additional background information, or additional examples of compliance submittals.

Although the organizational format is not fixed, all information contained in the ACM Compliance Documentation must be easy to find through use of a detailed Table of Contents and/or an Index.

4.3.1.2 Modeling Guidelines

Description: The ACM Compliance Documentation must contain clear and detailed information on how to use the ACM to model buildings for compliance with the Standards. At a minimum, the ACM Compliance Documentation must provide explanations and instructions outlined in Section 3.2.

Each ACM Compliance Documentation or User's Manual must include a general listing of the following:

1. Description of the value or values associated with each of input.
2. Restrictions on each variable.
3. Listing of the range beyond which inputs are unreasonable for any variable.
4. Description of options for any user-defined variable.

4.3.1.3 Statement

Description: The following statement must appear, in a box, within the first several pages of the ACM Compliance Documentation:

[ACM Name] may be used to show compliance with California's Energy Efficiency Standards for Nonresidential Buildings only when the following reference documents are readily available to the program user:

1. ~~1998-2001 Building Energy Efficiency Standards (P400-9800-03101)~~
2. Nonresidential Manual (P400-98-005) and its 2001 Supplement

Both publications are available from:

*California Energy Commission
Publications Office
1516 Ninth Street, MS-13
P.O. Box 944295
Sacramento, CA 94244-2950
(916) 654-5200*

4.3.1.4 Copies of ACM Compliance Documentation

Description: ACM vendors are required to make a copy of the ACM Compliance Documentation available to any California building department that requests it.

4.3.1.5 Commission Approval

Description: A section of the ACM Compliance Documentation must include a copy of the official Commission notice of the approval of the ACM. The notice may include restrictions or limitations on the use of the ACM. It will also include the date of approval, and may include an expiration date for approval as well. The notice will indicate optional capabilities for which the ACM is approved and other restrictions on its use for compliance. The Commission will provide this notice upon completion of evaluation of the ACM application.

4.3.2 Required Loads Capabilities

4.3.2.1 Conditioned Floor Areas

Description: The ACM Compliance Documentation must describe how the user determines and enters the conditioned floor area for each occupancy area and for the building as a whole. The ACM Compliance Documentation must state that the conditioned floor area for spaces within the building DO NOT include the area under permanent floor-to-ceiling height partitions, but the conditioned floor area for the whole building includes the area under these partitions. This conforms with the Standards which define Conditioned Floor Area:

... is the floor area (in square feet) of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces of exterior walls enclosing conditioned space.

But for internal and enclosed spaces lighting power allotments for the Area Category Method are determined from floor areas:

... Where areas are bounded or separated by interior partitions, the floor space occupied by those interior partitions shall not be included in any area.

4.3.2.2 Exterior Opaque Surfaces

Description: The ACM Compliance Documentation must include the following information.

1. The conditioned floor area of all conditioned space (i.e., all directly or indirectly conditioned space) must be included in the performance analysis. For a definition of conditioned space, see Section 101(b) of the Standards.

2. All directly or indirectly conditioned volume must be included in the analysis.
3. Every exterior partition of the proposed building must be modeled.

The Standards define an exterior partition as:

... an opaque, translucent, or transparent solid barrier that separates conditioned space from ambient air or space that is not enclosed.

4. Every slab-on-grade and underground walls and floors of the proposed building must be modeled.
5. Partitions separating the conditioned space from the courtyard are exterior partitions and must be modeled as such by the ACM.
6. Demising partitions are defined in the Standards as:

... solid barriers that separate conditioned space from enclosed unconditioned space.

Demising partitions may not be modeled as exterior partitions. They are modeled as interior walls constructed according to the plans and specifications for the building. If the enclosed unconditioned space is not included in the permit, the demising partition must be modeled as an adiabatic partition for both the standard and the proposed buildings.

4.3.2.3 Interior Surfaces

Description: The ACM Compliance Documentation must include the following information.

1. All interior floors must be modeled.
2. Atria are considered indirectly conditioned spaces and partitions separating the conditioned space from atria are interior surfaces.
3. All interzone and interior walls must be modeled as air walls with no heat capacity and U-valueU-factor of 1 Btu/h-ft²-°F. The ACM automatically accounts for the heat capacity of all interzone and interior walls by modeling them as light mass.

4.3.2.4 Materials

Description: The ACM Compliance Documentation must explain how the user can simulate different materials as required to make-up different assemblies including *thickness*(feet), *density*(pounds per cubic foot), *specific heat*(Btu per pound per degree F) and *thermal conductivity*(Btu-ft per hour per square foot per degree F).

4.3.2.5 Construction Assemblies

Description: The ACM Compliance Documentation must explain that the user must determine the ~~U-value~~U-factors of assemblies --wood frame, steel frame, masonry, and composite-- and that they must be calculated according to the methods described in Chapter 2.

Note that the ~~U-value~~U-factor requirements for exterior partitions in the Standards include the fixed outside air film assumed in the Nonresidential Manual, but the reference method and other energy analysis computer programs extract this fixed outside air film value and recalculate the outside air film resistance on an hourly basis as a function of wind speed.

4.3.2.6 Absorptance

Description: The ACM Compliance Documentation must describe how the user enters the value for the absorptance.

ACM Compliance Documentation must explain that the ACM user can specify opaque exterior wall or roof/ceiling construction between 0.90 and 0.20 absorptance, and that the program will warn and print an exceptional condition on the PERF-1 whenever the absorptance is less than 0.50 for an opaque exterior partition. The ACM Compliance Documentation must explain what happens if the user does not specify an absorptance. The ACM Compliance documentation must explain to the user how to enter the values for cool roofs and must describe the rating methods and installation criteria that are required for cool roofs.

4.3.2.7 Surface Orientation and Tilt

Description: The ACM Compliance Documentation must describe how the user enters the surface orientation (azimuth) and tilt of each exterior partition.

4.3.2.8 Heat Capacity

Description: The ACM Compliance Documentation must describe to the user how to specify and account for the heat capacity of opaque exterior walls.

The ACM Compliance Documentation must describe to the user how to:

- a) Distinguish between an *exterior wall* as defined in the standards and other wall types (e.g., demising wall); and
- b) Distinguish between *wood frame*, *steel frame* and *other* wall assemblies.

4.3.2.9 Exterior Doors

Description: The ACM Compliance Documentation must explain how the user enters the construction, materials, orientation, tilt, locations, and areas for exterior doors.

The ACM Compliance Documentation must request the user to specify and account for the heat capacity of all exterior doors in the proposed design. The ACM Compliance Documentation must explain that exterior doors may be grouped together as one area if they have the same (within the tolerance allowed for ACMs) orientation, tilt, construction and materials.

4.3.2.10 Exterior Walls

Description: The ACM Compliance Documentation must describe how the user enters area, and heat capacity of exterior walls.

The ACM Compliance Documentation must describe how to enter the information to determine the Exterior Wall Area as:

$$\text{Gross Exterior Wall Area} = (\text{Vertical Fenestration Area} + \text{Door Area})$$

where the Vertical Fenestration Area is equal to or less than the value explained below.

The ACM Compliance Documentation must request the user to specify and account for the heat capacity of opaque exterior walls in the proposed design, and how to specify and account for the ~~U-value~~U-factor of walls. The ~~U-value~~U-factor of walls may be weight averaged over the area of walls only when the walls are in the same occupancy and system area and have the same azimuth, the walls have the heat capacities within 10% of each other, and the walls are of the same construction type as described in Table 1-H and 1-I of the Standards.

4.3.2.11 Underground Walls

Description: The ACM Compliance Documentation must describe the parameters that users must enter to model underground walls. The ACM Compliance Documentation must require users to separately identify exterior walls separating conditioned space from adjacent earth, and request users to provide sufficient construction/assembly information to simulate walls accurately.

4.3.2.12 Exterior Roofs/Ceilings

Description: The ACM Compliance Documentation must describe how the user enters area, and heat capacity of exterior roofs/ceilings and must describe the standard roof/ceiling.

The ACM Compliance Documentation must explain how the user enters

roof/ceiling construction/assembly information to simulate roofs/ceilings accurately.

The ACM Compliance Documentation must describe how the user enters the information to determine the Exterior Roof/Ceiling Area as:

Gross Roof/Ceiling Area - Skylight Area

The ACM Compliance Documentation shall describe how to enter each exterior roof assembly, including construction, orientation and tilt, location and area for all roofs as they occur in the construction documents. Exterior roofs that have the same heat transfer characteristics, mass characteristic and that are in the same occupancy and system areas and are exposed to the same outside conditions may be combined for the purposes of entering the area of the roof assembly. In addition, the ACM Compliance Documentation must describe to the user the acceptable methods of calculating an overall ~~U-value~~ U-factor of the assembly, as described in Section 141(c) of the energy efficiency standards.

4.3.2.13 Exterior Raised Floors

Description: The ACM Compliance Documentation must describe how the user enters area, and heat capacity of exterior raised floors and must describe the standard raised floor.

The ACM Compliance Documentation must explain how the user enters raised floor construction/assembly information to simulate raised floors accurately.

The ACM Compliance Documentation shall provide the user with the following information:

The standard design raised floor assemblies are dependent on the HC of the proposed exterior raised floor. The standard design raised floor assemblies are determined as follows:

- $HC < 7.0$: The standard assembly is a wood framed, lightweight raised floor with a ~~U-value~~ U-factor matching the requirement listed in Table 1-H or 1-I of the Standards for wood framed walls and the applicable climate zone.
- If $HC \geq 7.0$: The standard assembly is two layers:
 1. Carpet and pad, R-value = 2.03;
 2. 100 lb./cubic foot concrete slab with a thickness such that the total heat capacity of the standard assembly matches the heat capacity of the proposed floor assembly and the overall ~~U-value~~ U-factor including carpet and pad matches the applicable value listed in Table 1-H or 1-I of the standards for the applicable climate zone.

4.3.2.14 Concrete Slab Floors on Grade

Description: The ACM Compliance Documentation must describe how the user enters area and heat capacity of concrete slab on grade floors.

The ACM Compliance Documentation must explain how the user enters slab floor construction/assembly information to simulate slab-on-grade floors accurately.

The ACM Compliance Documentation shall provide the user with the information on how to enter slab constructions and areas as they occur in the construction documents.

4.3.2.15 Underground Walls and Floors

Description: The ACM Compliance Documentation must describe the parameters that users must enter to model underground walls and floors. The ACM Compliance Documentation must require users to separately identify floors separating conditioned space from adjacent earth, and request users to provide sufficient construction/assembly information to accurately simulate the heat transfer and heat capacity of the floors.

The ACM Compliance Documentation shall require the user to enter underground floor constructions and areas as they occur in the construction documents.

4.3.2.16 Fenestration Products

Description: The ACM Compliance Documentation must describe how the user enters information about the characteristics of fenestration products in both walls and roof/ceilings that effect the energy use of the building. The features that must be explained in the ACM Compliance Documentation are described in the following sections.

4.3.2.17 Fenestration Orientation and Tilt

Description: The ACM Compliance Documentation must describe how the user enters the actual azimuth (direction) and surface tilt of glazing surfaces in each surface. The user shall be instructed that the azimuth and surface tilt of each glazing surface shall be entered as it occurs in the construction documents rounded off to the nearest whole degree.

4.3.2.18 Fenestration Thermal Properties

Description: The ACM Compliance Documentation must describe that, for each manufactured fenestration product, the user must input the fenestration's overall U-value U-factor and SHGC from the NFRC label. The ACM Compliance Documentation must also describe that, for each site assembled or field-fabricated fenestration product, there are ~~two~~ three alternatives for modeling the thermal properties; (1) the user uses the U-factor determined using the NFRC certification for Site-Built Products and the SHGC calculated as shown in Appendix I, (2) the user inputs the default U-value U-factor from Table 1-D and the Solar Heat Gain Coefficient from Table 1-E in the standards; (23) the user determines the U-factor from Appendix I and calculates the U-value and SHGC of the fenestration assembly as shown in Appendix I or by using a method approved by the Commission. The ACM Compliance Documentation must also describe that default values are used when no entries are made.

The ACM Compliance Documentation shall explain that the basis of the standards is the appropriate maximum U-value U-factor and the Relative Solar Heat Gain or the Solar Heat Gain Coefficient from Tables 1-H and 1-I of the Standards according to occupancy and climate zone.

4.3.2.19 Glazing in Exterior Walls and Shading

Description: The ACM Compliance Documentation must describe how to model heat transfer through all glazed (transparent or translucent) surfaces of the building envelope walls. The user must account for many features of exterior glazing in walls. These features, including all standard and proposed modeling assumptions and inputs, are described in the following sections.

4.3.2.20 Area of Fenestration in Walls and Doors

Description: The ACM Compliance Documentation shall explain how the user must model the exposed surface area of each transparent or translucent surface. Fenestration surfaces include openings in the walls and vertical doors of the building. The ACM Compliance Documentation shall describe how to enter the following:

- *Fenestration Area in Walls and Doors.* For each glazing surface, the user must enter the area of glazing surface associated with a zone. This area is the rough-out opening for the window(s). The areas of fenestration in walls and doors shall only be grouped when they have the same U-value U-factor, orientation, tilt, shading coefficient, relative solar heat gain and relationship to shading from exterior devices such as overhangs or side fins. Fenestration in demising walls may not be grouped with fenestration in exterior walls or doors.
- *Display Perimeter.* When the ACM calculates the standard glazing/fenestration area based on the display perimeter, the ACM Compliance Documentation must describe how the user enters parameters for display perimeter. The user must specify a value, in feet,

for each zone on each floor or story of the building that abuts a public sidewalk. The value is used as an alternate means of establishing Maximum Fenestration Area in the standard design (Title 24, § 143). As defined in Section 101(b) of the Standards, display perimeter is:

.. the length of an exterior wall in a B-2 occupancy that immediately abuts a public sidewalk, measured at the sidewalk level for each story that abuts a public sidewalk.

- *Floor Number.* The ACM Compliance Documentation must describe how to determine each floor (story) of a building and how to determine if there is a Display Perimeter associated with each floor (story) of the building, and that a public sidewalk must be surfaced with a material considered acceptable for sidewalks by the local codes, must be readily accessible to the public view. The ACM Compliance Documentation shall explain that the display perimeter is intended for applications where retail merchandise needs to be viewed by the passing public.

The ACM Compliance Documentation must explain that the *Maximum Fenestration Area* is 40% of the gross exterior wall area of the entire permitted space or building that can be occupied, or, if Display Perimeter is specified, the *Maximum Fenestration Area* is either 40% of the gross exterior wall area of the entire permitted space or building, or six feet times the Display Perimeter for the entire permitted space or building, whichever value is greater.

The ACM Compliance Documentation shall describe how to determine the gross exterior wall area.

4.3.2.21 Solar Heat Gain Coefficients of Fenestration in Walls and Doors

Description: The ACM Compliance Documentation shall explain how to determine solar heat gain coefficients and relative solar heat gains for fenestration in walls and doors, as defined in the Standards, and shall explain how and when each is used in modeling the characteristics of buildings. The ACM Compliance Documentation shall describe how and when the user enters solar heat gain coefficient from the Commission default Table or an NFRC label. This solar heat gain coefficient (SHGC) shall apply to the full fenestration area. Fenestration solar heat gain coefficient for each glazing surface shall be entered as it occurs in the construction documents for the building.

The ACM Compliance Documentation shall explain to the user that the basis of the standards are the appropriate maximum RSHG values from Tables 1-H and 1-I of the Standards according to occupancy type, climate zone and orientation. The ACM Compliance Documentation must note that the maximum RSHG is different for north oriented glass; and that, for the purposes of establishing standard design RSHG, north glass is glass in exterior walls and doors facing from 45° west (not inclusive) to 45° east (inclusive) of true north.

For nonresidential buildings, high-rise residential buildings and hotels and motels, approved methods for accounting for the shading effects of site assembled, and field-fabricated fenestration assemblies are the information reported on an

approved NFRC label, CEC's default Table (Table 1-E of the standards), and the value calculated in Appendix I or other by a Commission approved methods. This shading information which includes the effects of glass, framing and mullions applies to the entire window area. Effects such as the buildup of dirt on windows are not considered differential effects between the proposed and standard design which result in energy savings. These effects are intentionally neglected by the reference method and must be considered the same in proposed and standard designs for ACMs.

4.3.2.22 Overhangs

Description: The ACM Compliance Documentation must describe how users model overhangs over windows. The ACM Compliance Documentation must describe how the user enters the following:

- *Overhang projection.* The distance the overhang projects horizontally from the plane of the window.
- *Height above window.* The distance from the top of the window to the overhang.
- *Window height.* The height of the top of the window from the bottom of the window, to which the overhang is applied.
- *Overhang Extension.* The distance the overhang extends past the edge of the window jams.

The ACM Compliance Documentation shall instruct the user to simulate overhangs in the proposed design for each window as they are shown in the construction documents. Overhangs may not be grouped they are applied to windows facing the same direction with the same window height and the overhang has the same overhang projection, height above window, and the overhang is continuous from one window in the group to another.

4.3.2.23 Vertical Shading Fins

Description: The ACM Compliance Documentation shall describe how vertical shading fins are modeled, and will describe the constraints on the use of vertical shading fins. These fins must be attached to the building. Objects that are separate from the building, such as adjacent buildings, may not be modeled as vertical fins.

4.3.2.24 Exterior Fenestration Shading Devices

Description: The ACM Compliance Documentation shall describe how the user enters parameters describing exterior fenestration shading devices. The ACM Compliance Documentation shall describe any restrictions on the parameters. These devices must be attached to the building that the user is modeling for compliance.

4.3.2.25 Window Management

Description: The ACM Compliance Documentation must describe how the ACM models window management and emphasize that this management is an assumption required for all ACMs, not a user option. The assumptions regarding window management include the effects of well-operated interior draperies. The ACM Compliance Documentation shall include the description of the proposed design assumptions that include interior drapes with a *solar heat gain coefficient multiplier* of 0.80.

4.3.2.26 Glazing or Fenestration in Exterior Roofs (Skylights)

Description: The ACM Compliance Documentation must explain how to model heat transfer through all glazing or fenestration (transparent and translucent) in exterior roofs of the building envelope. The user must account for many features of such glazing. These features, including all standard and proposed modeling assumptions and inputs, are described in the following sections.

4.3.2.27 Fenestration Areas of Glazing in Exterior Roofs (Skylights)

Description: The ACM Compliance Documentation shall describe how the user must model the exposed surface area of each transparent or translucent surface, and must describe how the user must enter the proposed design fenestration areas as they are shown in the construction documents. Fenestration surfaces in roofs include openings in roofs and horizontal roof doors of the building.

The ACM Compliance Documentation must explain how the ACM determines the effects of these fenestration areas, include describing that:

1. When the Skylight Roof Ratio in the proposed design is ≤ 0.05 , the standard design shall use the same fenestration area as on each proposed design exterior roof.
2. When the Skylight Roof Ratio in the proposed design is > 0.05 , the ACM shall determine the horizontal fenestration area of the standard design by multiplying the fenestration area in each exterior roof by a fraction equal to:

$$SRR_{\text{standard}}/SRR_{\text{proposed}}$$

The ~~U-value~~U-factor and solar heat gain coefficients of individual skylights may be combined by area-weighted averaging only if they are not being used for daylighting and if they are in the same zone.

4.3.2.28 Occupancy Types

Description: The Alternative Calculation Method (ACM) Compliance Documentation shall describe the use of the following *occupancy* types for spaces or buildings when lighting plans are submitted for the entire building or when lighting compliance is not performed:

- Commercial and Industrial Work
- Grocery Store
- Industrial and Commercial Storage
- Medical/Clinical
- Office
- Other
- Religious Worship, Auditorium, Convention Center
- Restaurant
- Retail and Wholesale Store
- School
- Theater
- Unknown

The ACM *area occupancy* selection list and Alternative Calculation Method (ACM) Compliance Documentation descriptions must include these *area occupancy* types for spaces when lighting plans are submitted for portions or for the entire building or when lighting compliance is not performed:

- Auditorium
- Auto Repair Workshop
- Bank/Financial Institution
- Bar, Cocktail Lounge and Casino
- Beauty Shop
- Barber Shop
- Classroom
- Commercial/Industrial Storage
- Commercial/Industrial Work - General, High Bay
- Commercial/Industrial Work - General, Low Bay
- Commercial/Industrial Work - Precision
- Convention, Conference and Meeting Center
- Corridor, Restroom and Support Area
- Courtrooms
- Dining Area
- Dry Cleaning (Coin Operated)
- Dry Cleaning (Full Service Commercial)
- Electrical, Mechanical Rooms
- Exercising Rooms and Gymnasium
- Exhibit Display Area and Museum
- Grocery Sales Area
- High-Rise Residential
- Hotel Function Area
- Hotel/Motel Guest Room
- Kitchen and Food Preparation
- Laundry
- Library - Reading Area

- Library - Stacks
- Lobby - Hotel
- Lobby - Main Entry
- Lobby - Office Reception/Waiting
- Locker/Dressing Room
- Lounge/Recreation
- Mall, Arcade and Atrium
- Medical and Clinical Care
- Mixed Occupancy
- Office
- Other
- Religious Worship
- Retail Sales, Wholesale Showroom
- Smoking Lounge
- Theater (Motion Picture)
- Theater (Performance)
- Unknown

The ACM Compliance Documentation must require users to enter the occupancy(s) of each conditioned area or space being modeled. The user should select the occupancy that most closely matches the occupancy specified in Table 2-1 or Table 2-2. The user's occupancy selection should be based on the actual occupancy of the space(s) not on the amount of lighting or other energy use aspects desired. The ACM Compliance Documentation should guide the user on how to determine an occupancy based on occupancy use similarities and limit occupancy lighting information and other occupancy assumptions to references to this Manual or an appendix. By virtue of the categories "other" and "unknown" the occupancy tables are complete and address all possible occupancies. The local enforcement agency (not the ACM user/permit applicant) has the discretion to determine if the user's occupancy choices are reasonable and correct.

If the ACM has an independent occupancy selection for ventilation, the ACM Compliance Documentation must describe how best to select a ventilation occupancy and may describe ventilation assumptions.

The ACM Compliance Documentation is not the forum to argue the validity of *area occupancy* assumptions, nor should the ACM or the ACM Compliance Documentation be written so that either encourages debates about *area occupancy* assumptions or debates about choosing occupancies based on these assumptions. The Commission strongly encourages vendors to reference these assumptions by referring to Chapter 2 of this manual, but these assumptions may also be provided in an appendix to the ACM Compliance Documentation.

4.3.2.29 Mixed Occupancies

Description: The ACM Compliance Documentation shall explain how the user may select *mixed* as the occupancy type when selecting an area occupancy. Area occupancy types may only be mixed when they are all within the same zone, have the same operating schedules and when none of the occupancies includes process loads.

The ACM Compliance Documentation shall describe how the user, if *mixed* is selected as the area occupancy type, enters the following:

1. Total area of the zone,
2. Area and square footage of up to four different area occupancy types.

Note that the areas specified do not include the area of interior partitions for the purposes of determining lighting wattages in accordance with the standards. The reference method assumes that 1% of the floor area is occupied by interior partitions. The ACM Compliance Documentation shall describe how the ACM automatically calculates the sum of the areas for the four different occupancies:

- If the sum of the four different areas is greater than the input total area of the zone, the ACM will abort or ask for corrected input.
- If the sum of the four different occupancies is less than the input total area of the zone, the ACM will assign the occupancy *other* to the additional area needed to equal the input total area.

The ACM Compliance Documentation shall explain that the ACM will assign default assumptions for occupant densities, outside air ventilation rates, lighting loads, receptacle loads and service water heating loads by calculating the area weighted average for each of these inputs, using the areas input by the user. Refer to sections for *lighting*, *ventilation loads* and *process loads* for respective requirements for each of these adjustments.

4.3.2.30 Occupant Loads

Description: The ACM Compliance Documentation shall explain that these values are automatically selected by the ACM based on the occupancy.

4.3.2.31 Receptacle Loads

Description: The ACM Compliance Documentation shall explain that these values are automatically selected by the ACM based on the occupancy type and that the receptacle loads include the process energy produced by equipment that are plugged into receptacle outlets such as personal computers and printers.

4.3.2.32 Process Energy

Description: The ACM Compliance Documentation shall explain that the process energy is limited to the energy produced by equipment whose locations are specified on the plans or other construction documents. The compliance documentation shall clearly explain that the energy generated by plugged-in devices such as office equipment must not be modeled as process energy. The thermal energy from such devices are included in the plug loads shown in Table 2-1 or 2-2.

4.3.2.33 Ventilation

Description: The ACM compliance documentation shall explain that the ventilation level is based on the selected occupancy(s) and cannot be altered by the user. The compliance documentation shall explain that process ventilation may be input by the user for compliance simulations.

The compliance documentation must inform the user that they must justify the need for nonzero tailored ventilation values to the satisfaction of the local enforcement agency.

4.3.2.34 Water Heating

Description: Refer to Section 2.5 , Required Systems and Plant Capabilities for modeling requirements for service water heating systems.

4.3.2.35 Lighting

Description: The ACM Compliance Documentation shall describe how users enter lighting parameters. The documentation shall describe how to enter lighting for each space being modeled. The ACM Compliance Documentation shall request the user to indicate one of the following conditions for the building:

1. *Lighting compliance not performed.* The ACM Compliance Documentation must require the user to enter the occupancy type of each space from Table 2-1 or 2-2 of this manual. The documentation must explain that Table 2-1 may be used even if the building has multiple occupancies.
2. *Lighting compliance performed.* The ACM Compliance Documentation must require the user to indicate whether lighting plans will be submitted for a portion of the building or for the entire building (excluding the residential units of high-rise residential buildings and hotel/motel guest rooms). If lighting plans will be submitted for a portion of the building, the documentation must require the user to select the occupancy type of each space from Table 2-2 of this manual. However, if lighting plans will be submitted for the entire building, the ACM Compliance Documentation must require the user to select the occupancy type of each space from Table 2-1 or 2-2 of this manual. The documentation must explain that for spaces without specified lighting level, the ACM selects the default lighting level from Table 2-2.

The ACM Compliance Documentation must explain that if the *modeled* Lighting Power Density (LPD) is different than the *actual* LPD calculated from the fixture schedule for the building, ACMs shall model the larger of the two values for the compliance run and shall print that value for “Installed Lighting” on PERF-1.

With a specific set of lighting plans that meets the prescriptive tailored lighting requirements and the submittal of the prescriptive *Tailored LPD Summary and Worksheet Forms*, LTG-4, for each HVAC zone with a tailored lighting power entry, the user may choose to enter the Total Allowed Watts from Line 4, Part 1 of LTG-4 as a *Tailored Lighting Allotment* entry for that HVAC zone.

The ACM Compliance Documentation may also request the user to enter the Tailored Lighting Allotment and lighting control credits for each zone when they are applicable and the ACM uses those features.

If a value is input for the Tailored Lighting Allotment, the user shall provide lighting plans that comply with the prescriptive requirements and all necessary Tailored Lighting Forms and Worksheets (LTG-4) documenting the lighting and its justification as part of the compliance documentation.

If a value is input for lighting control credits, the user shall provide documentation that lighting control credits have been used in compliance and provide the lighting Control Credit Watts from Column I for Building Total from LTG-3, Lighting Controls Credit Worksheet. For the performance compliance approach user/applicants may not take credit for lighting controls that would otherwise be required by the Standards, especially by mandatory requirements. The ACM Compliance Documentation must spell out this limitation of lighting control credits. If the ACM allows the user to select from various types of lighting controls, the ACM Compliance Documentation must warn users that the control type selected must be installed in the entire floor area in the space or zone modeled in the program.

4.3.2.36 Enclosed Unconditioned and Semi-Conditioned Spaces

Description: The ACM Compliance Documentation shall describe unconditioned and semi-conditioned spaces and that they are modeled using the same rules. The ACM Compliance Documentation shall also explain that enclosed conditioned and semi-conditioned spaces must be modeled if they are included in the permitted space and that modeling them is optional if they are not part of the permitted space.

If enclosed conditioned or semi-conditioned spaces are not modeled, the demising partition separating the conditioned space from the enclosed unconditioned or semi-conditioned space is modeled as an adiabatic partition (see Section 2.2.2.5).

4.3.2.37 Indirectly Conditioned Spaces

Description: The ACM Compliance Documentation shall explain that ACMs explicitly simulate all indirectly conditioned spaces, and that users may choose to simulate indirectly conditioned spaces as part of the directly conditioned space provided that the total volume and area of indirectly conditioned spaces included are each less than 15% of the total volume and area of the total indirectly and directly conditioned volume and area.

For the purpose of this manual, indirectly conditioned spaces are those which

either can be occupied or cannot be unoccupied.

The requirements for each of these three cases are documented below.

Indirectly Conditioned Spaces Included in Directly Conditioned Space

The ACM Compliance Documentation shall describe how the user enters this space. The space must use the same configuration and occupancy characteristics as occurs in the construction documents, including envelope performance, occupancy characteristics and lighting levels.

Indirectly Conditioned Spaces that can be occupied and Explicitly Modeled

The ACM Compliance Documentation must describe how the user must explicitly identify indirectly conditioned space which can be occupied.

Indirectly Conditioned Spaces that cannot be occupied and Explicitly Modeled

The ACM Compliance Documentation must describe how the user must explicitly identify indirectly conditioned space which cannot be occupied. The ACM Compliance Documentation must instruct the user to specify the amount of light heat to be rejected to this space.

4.3.2.38 Light Mass

Description: The ACM Compliance Documentation shall describe how users enter parameters to approximate the mass effects of all interior partitions and furniture. When the ACM allows the user to enter information on lightweight mass, the ACM Compliance Documentation shall describe how to determine appropriate entries and restrictions on user entries for the spaces described below:

- ***Directly Conditioned and Indirectly Conditioned Space Which Can be Occupied:*** The reference method models lightweight mass through the use of "heavy" furniture weighing 80 pounds per square foot of floor area. In this method, there is an 85% chance that sunlight will fall upon furniture as opposed to the floor.
- ***Indirectly Conditioned Spaces Which Cannot be Occupied:*** For these spaces the reference method models lightweight mass by using a light furniture category of 30 pounds per square foot in DOE 2.1 to generate the lightweight standard weighting factors for these spaces.

4.3.3 Required Systems and Plant Capabilities

The ACM Compliance Documentation must describe the application of the energy source conversion factor and any features of the program for which the user must consider this factor.

4.3.3.1 Thermal Zones

Description: The ACM Compliance Documentation must describe the number of thermal zones (a minimum of fifty) that the ACM is capable of modeling and the minimum control capabilities that must be included in each of these zones.

As described in Chapter 2, if a proposed building design has twenty thermostats or less the ACM Compliance Documentation must require the user to model the same number of zones as there are independent thermostats. Hence zones may only be combined when there are more than twenty (20) HVAC zones in a proposed building design. The methods of combining thermal zones shall be consistent with the definition *ZONE, SPACE CONDITIONING* in Section 101(b) of the Standards. This definition states:

ZONE, SPACE CONDITIONING is a space or group of spaces within a building with sufficiently similar comfort conditioning requirements so that comfort conditions, as specified in 144(b)3 or 150(h), as applicable, can be maintained throughout the zone by a single controlling device.

The ACM Compliance Documentation must explain the characteristics that will lead to zones being similar, so they may be combined into one zone for modeling purposes, and the characteristics that will lead to the zones being dissimilar. An example of similar zones may be central core areas on multiple floors of a multi-story building when they are served by the same system or systems of the same category. See Section 4.3.3.19 for combining like systems. An example of dissimilar zones may be a perimeter area on one facade of a building, part of which includes glazing and part of which has no glazing. The conditions in these two areas are sufficiently dissimilar that the areas should be treated as two zones (if they are independently controlled) even though they are on the same floor and facing the same orientation.

The ACM Compliance Documentation should also emphasize that the distribution of heating and cooling must be well balanced across any area that is to be considered as one zone.

Zoning the building for compliance calculations must be consistent with the actual zoning of the building if the actual zoning is known at the time of the analysis. If there are more actual zones than the program is capable of modeling, actual zones may be merged together for compliance purposes, as long as it can be established that the actual zones being grouped together for compliance are *thermodynamically similar* such that physical comfort could be maintained by a single thermostat or HVAC-controlling device/sensor.

The ultimate test is to use non-coincident load calculations to show that actual zones grouped together for compliance calculations have the same or similar peak heating and cooling load profiles. This is done with a design load calculation which considers the peak load by month and hour.

Typically, physical zones which have the same or similar glazing orientation(s), the same or similar glazing area to floor area and the same occupancy types will be thermodynamically similar since, for example, they experience their peak cooling loads at the same hour. These zones can be merged together for compliance calculations.

The compliance documentation should tell the ACM user if the standard design uses exactly the same zoning in the proposed building design as the reference

method does.

The ACM Compliance Documentation shall also describe how to zone a building that does not include an HVAC system in the design. Any building or separate permitted space smaller than 2500 ft² in conditioned floor area without an HVAC system or design may be modeled as having only a single HVAC zone. However, for buildings or permitted spaces 2500 ft² and greater, each floor of the building shall be divided into multiple thermal zones according to the following procedure:

1. Determine the ratio (R) of the floor's total conditioned area to the gross exterior wall area associated with the conditioned space.
2. For each combination of occupancy type and exterior wall orientation create a perimeter zone. The floor area of each perimeter zone shall be the gross exterior wall area of the zone times R or 1.25, whichever is smaller.
3. Model the exterior space adjacent to each wall orientation as a separate exterior zone. Spaces adjacent to walls which are within 45 degrees of each orientation shall be included in the zone belonging to that orientation.
4. For cases where R is greater than 1.25, create an interior zone for each occupancy type. For each occupancy type, the floor area of the interior zone shall be the total area less the floor area of the perimeter zones created in paragraphs 2 and 3 above.
5. Prorate the roof area and the floor area among the zones according to the floor area of each zone. Prorate the roof and floor areas among the perimeter zones created in paragraphs 2 and 3 above according to the floor area of each exterior zone.
6. Assign skylights to interior zones. If the skylight area is larger than the roof area of the interior zone, then the skylight area in the interior zone must be equal to the roof area in the interior zone and the user must prorate the remaining skylight area among the perimeter zones based on the floor area.
7. If the area of the zone is less than 300 ft², combine it with its adjacent zone of the same occupancy type and zone type (interior or exterior).
8. Courtyards are considered outside or ambient air. Walls, floors, and roofs separating conditioned spaces from courtyards are exterior walls, floors, and roofs. Create an exterior zone for each wall orientation separating the conditioned space from the courtyard. The user shall not combine these exterior zones with other exterior zones even if their exterior walls have the same orientation.
9. Model spaces adjacent to demising walls as interior zones. Combine these zones with other interior zones within the same occupancy type.
10. Ignore all interior walls and model partitions separating thermal zones as air walls with ~~U-value~~ U-factor of 1.0 Btu/h-ft²-°F.

Since the Commission considers a larger number of modeled HVAC zones to be a more accurate representation, the ACM Compliance Documentation must inform ACM users that the local enforcement agency may (at its own discretion) require

the applicant to model additional HVAC zones.

4.3.3.2 Primary Systems

Description: The ACM Compliance Documentation must include a list of the primary systems that the ACM can model. The ACM Compliance Documentation shall explain each required input parameter that is needed to describe each primary system, and shall explain how the user determines the appropriate input for any proposed design that will use the input.

The ACM Compliance Documentation shall also describe any constraints on each primary system, such as maxima, minima, ranges, or specific design applications.

4.3.3.3 Cooling Equipment

Description: The ACM Compliance Documentation must describe how the user must enter parameters that describe cooling equipment type, efficiency, capacity, or other parameters that are required to model the operation of the cooling system. The ACM Compliance Documentation must describe to the user how to enter the number and names of zones served by the HVAC system so that the ACM may determine the use of single or multizone systems and so that the user correctly assigns each zone to an HVAC system serving it. The ACM Compliance Documentation must describe how the user must enter parameters that determine the required efficiency of the equipment, the efficiency descriptor that must be used, and, when applicable, heat transfer fluid.

The ACM Compliance Documentation must describe each type of cooling equipment that the ACM is capable of modeling, and any constraints, such as maxima, minima, or ranges, that the user must consider when modeling specific equipment.

4.3.3.4 Heating Equipment

Description: The ACM Compliance Documentation must describe how the user must enter parameters that describe heating equipment type, efficiency, capacity, or other parameters that are required to model the operation of the heating system. The ACM Compliance Documentation must describe how the user must enter parameters that determine the required efficiency of the equipment, the efficiency descriptor that must be used, and , when applicable, the part load ratio and heat transfer fluid.

The ACM Compliance Documentation must describe each type of heating equipment that the ACM is capable of modeling, and any constraints, such as maxima, minima, or ranges, that the user must consider when modeling specific equipment.

4.3.3.5 Standard Design System Selection

Description: The ACM Compliance Documentation must include a description of the required user input for:

- Building Type
- System Type (especially Single Zone or Multi-Zone)
- Heating Source
- Cooling Source

so that the ACM and the reference method can properly determine the Standard HVAC System and Plant in the standard building design.

The purpose of the ACM Compliance Documentation is to explain the proper use of the ACM for compliance purposes rather than the detailed procedures and assumptions of the reference method already described in this manual or in the ACM's technical documentation. The ACM Compliance Documentation shall NOT describe the standard design system types that are used to generate the standard design budget, and shall NOT describe which system types in the standard design must be used as the basis for comparison to proposed design system types. Such information may be included as a separate Technical Engineering Document for the ACM.

The ACM Compliance Documentation shall describe any restrictions or limitations that the user should apply when entering parameters that describe the systems.

4.3.3.6 Cooling Efficiency of DOE Covered Air Conditioners

Description: The ACM Compliance Documentation shall describe how the user determines the proper efficiency descriptor for air conditioners that are **Covered Consumer Products**, and how the user must enter these descriptors into the ACM.

4.3.3.7 Cooling Efficiency of Packaged Equipment not Covered by DOE Appliance Standards

Description: The ACM Compliance Documentation shall describe how the user determines the proper efficiency descriptor for packaged air conditioners that are **not Covered Consumer Products**, and how the user must enter these descriptors into the ACM.

4.3.3.8 Efficiency of Cooling Equipment Included in Built-up Systems

Description: The ACM Compliance Documentation shall describe the required user input parameters for:

- Type of central water chilling plant equipment,
- The number of central chilling units,
- The capacity of each unit,
- The electrical input ratio of each central chilling unit
- The type of refrigerant to be used in each chilling unit.

4.3.3.9 Heating Efficiency of DOE Covered Equipment

Description: The ACM Compliance Documentation shall describe how the user determines the proper efficiency descriptor for heating equipment that are **Covered Consumer Products**, and how the user must enter these descriptors into the ACM.

4.3.3.10 Heating Efficiency of Equipment Not Covered by DOE Standards

Description: The ACM Compliance Documentation shall describe how the user determines the proper efficiency descriptor for heating equipment that are **not Covered Consumer Products**, and how the user must enter these descriptors into the ACM.

4.3.3.11 Electric Motor Efficiency

Description: The ACM Compliance Documentation shall explain that the motor efficiency must be determined as established in accordance with NEMA Standard MG1.

4.3.3.12 ARI Fan Power

Description: The ACM Compliance Documentation shall describe how users enter the fan power for each system type.

4.3.3.13 Process Fan Power

Description: The ACM Compliance Documentation shall explain that fans used exclusively for process must not be modeled in the compliance run. The Compliance Documentation shall describe how users must subtract out the portion of fan power used for process if the fan serves a process as well as conditioning the space.

4.3.3.14 Fan System Operations

Description: The ACM Compliance Documentation shall describe the required schedules that

are used for fan system operation. The documentation must explain how the ACM models intermittent fan operation for the residential units of high-rise residential buildings and hotel/motel guest rooms.

4.3.3.15 Fan Volume Control

Description: The ACM Compliance Documentation shall describe the types of fan volume control that are available to the user, and any restrictions on the use of each fan system.

4.3.3.16 Design Fan Power Demand

Description: The ACM compliance documentation shall describe how the user enters parameters describing the fan power. These parameters shall include the design brake horsepower, the design drive/motor efficiency, and the design motor efficiency, all at peak air flow rate. The parameters shall be provided for each supply and each return fan. The compliance documentation shall explain that if the user does not input the above required parameters, the ACM shall assume that no mechanical compliance will be performed and shall model the default mechanical system.

ACMs may combine return fans with the supply fan if and only if the controls are of the same type. For example, ACMs may combine fans if they all have variable speed drive control or if they all are constant volume fans.

4.3.3.17 Air Economizers

Description: The ACM Compliance Documentation shall describe when economizers are required and when they are used as the basis of the performance compliance. The ACM Compliance Documentation shall also describe how to enter parameters describing the economizer and its method of operation. The ACM Compliance Documentation shall describe any restrictions on the modeling of economizers by the ACM.

4.3.3.18 Modeling Default Heating and Cooling Systems

Description: The ACM Compliance Documentation shall explain that the ACM automatically selects and models default heating and cooling systems identical to the standard systems defined in Section 2.4.2.4 (Standard Design Systems) for the following conditions:

1. *Mechanical compliance not performed.* The Compliance Documentation shall describe what parameters must be entered by the user to allow the ACM to select the proper default heating and cooling systems such as the building type and the number of thermal zones. The documentation must explain the

guidelines for zoning a building as described in Section 4.3.3.1 of this manual.

2. *Mechanical compliance performed with no heating installed.* The Compliance Documentation shall describe that the ACM automatically models the default heating system for spaces with no installed heating or spaces which use the existing heating system. The documentation shall also describe what parameters must be entered by the user to allow the ACM to select the proper default heating system such as the building type and the number of thermal zones in the permitted space.
3. *Mechanical compliance performed with no cooling installed.* The Compliance Documentation shall describe that the ACM automatically models the default cooling system for spaces with no installed cooling or spaces which use the existing cooling system. The documentation shall also describe what parameters must be entered by the user to allow the ACM to select the proper default cooling system such as the building type and the number of thermal zones in the permitted space.

4.3.3.19 Combining Like Systems

Description: ACMs must explain that users may model like systems together as one system provided the systems serve the same thermal zone or the thermal zones served by the individual units are similar and are being combined. The characteristics that leads to zones being similar are described in Section 4.3.3.1. The equipment being combined must also be all of the same category.

Multiple units of the same type fall into the following categories:

Cooling Equipment

- Single package < 65,000 Btuh
- Split system < 65,000 Btuh
- All package $\geq 65,000$ and $\leq 75,000$ Btuh
- All package > 75,000 and < 135,000 Btuh
- All package $\geq 135,000$ and $\leq 760,000$ Btuh

- Condensing Units, Air-Cooled $\geq 135,000$ Btuh
- Condensing Units, Water or Evaporatively Cooled $\geq 135,000$

- Water Chillers, Water-Cooled < 150 tons
- Water Chillers, Water-Cooled ≥ 150 and < 300 tons
- Water Chillers, Water-Cooled ≥ 300 tons, ozone safe refrigerants
- Water Chillers, Water-Cooled ≥ 300 tons, non-ozone safe refrigerants

- Water Chillers, Air-Cooled < 150 tons
- Water Chillers, Air-Cooled ≥ 150 and < 300 tons
- Water Chillers, Air-Cooled > 300 tons

Heating Equipment

- Heat pumps, single package < 65,000 Btuh

- Heat pumps, split system < 65,000 Btuh
- Heat pumps, all $\geq 65,000$ and $\leq 75,000$ Btuh
- Heat pumps, all > 75,000 and < 135,000 Btuh
- Heat pumps, all $\geq 135,000$ Btuh
- Boilers, gas fired < 300,000 Btuh
- Boilers, gas fired $\geq 300,000$ Btuh
- Boilers, oil fired < 225,000 Btuh
- Boilers, oil fired $\geq 225,000$ and < 300,000 Btuh
- Boilers, oil fired $\geq 300,000$ Btuh
- Boilers, residual oil fired, < 300,000 Btuh
- Boilers, residual oil fires, $\geq 300,000$ Btuh
- Furnaces, all fossil fuel fired < 225,000 Btuh
- Furnaces, gas fired $\geq 225,000$ Btuh
- Furnaces, oil fired $\geq 225,000$ Btuh

Fan Systems

- Constant volume, FPI ≤ 0.8 watts/cfm
- Constant volume, FPI > 0.8 watts/cfm
- Variable volume, ≤ 25 HP, FPI ≤ 1.25 watts/cfm
- Variable volume, ≤ 25 HP, FPI > 1.25 watts/cfm
- Variable volume, > 25 HP, FPI ≤ 1.25 watts/cfm
- Variable volume, > 25 HP, FPI > 1.25 watts/cfm

Water Heaters

- Electric storage
- Electric instantaneous
- Gas storage $\leq 75,000$ Btuh
- Gas storage > 75,000 Btuh
- Gas instantaneous

4.3.3.20 System Supply Air Temperature Control

Description: The ACM Compliance Documentation shall describe the control strategies that the ACM can model, and shall describe the parameters that the user must enter to model these strategies. At a minimum, the ACM Compliance Documentation must describe strategies for constant supply air temperature when heating or cooling, and outdoor air reset for the cooling supply air temperature.

4.3.3.21 Zone Terminal Control

Description: The ACM Compliance Documentation must describe when the user must enter zone terminal control parameters, and how the user must enter parameters for:

1. Variable air volume
2. Minimum box position

3. (Re)heating Coil
4. Hydronic Heating
5. Electric Heating

The ACM Compliance Documentation shall explain the criteria for minimum box position for variable volume systems.

4.3.3.22 Pump Energy

Description: The ACM Compliance Documentation shall explain that the ACM accounts for the pump energy for the hot water, chilled water, and condenser water piping systems. For multiple pump systems, the documentation shall explain how to calculate the weighted average pump efficiency for the system.

The ACM Compliance Documentation must show the default values for the hot water, chilled water, and condenser loop piping systems.

4.3.3.23 Chiller Characteristics

Description: The ACM Compliance Documentation shall describe how the user enters chiller parameters that are required in the ACM, the chiller options that are available within the ACM, and the constraints on these parameters. The documentation must also show default values for the chiller options.

4.3.3.24 Performance Curves for Electric Chillers

Description: The ACM Compliance Documentation shall explain that the ACM allows modeling custom performance curves for electric chillers. The documentation must describe the input requirements for calculating the regression constants for the chiller performance. The documentation must also explain that the ACM uses default performance curves if the user chooses not to make any entries.

4.3.3.25 Air-Cooled Condensers

Description: The ACM Compliance Documentation shall describe how the user is allowed to account for the characteristics of air-cooled condensers.

4.3.3.26 Cooling Towers

Description: The ACM Compliance Documentation shall describe how the user enters cooling tower parameters that are required in the ACM, the cooling tower options that are available within the ACM, and the constraints on these parameters. The

documentation must also show default values for the cooling tower options.

4.3.3.27 Service Water Heating

Description: The ACM Compliance Documentation shall describe the parameters that the user must enter to describe the water heating system, the efficiency of each water heater and the load that the water heater must meet. The ACM Compliance Documentation must also describe that the user must assign the load to individual water heaters when either more than one water heater is used to meet the load on one system, or when multiple systems are used in a building. When more than one water heater is used to meet the load for one system, the load distributed to each water heater in accordance with the following equation.

$$LOAD_k = LOAD_T \times \frac{OUTPUT_k + 453.75 \times VOL_k}{\sum_{m=1}^n (OUTPUT_m + 453.75 \times VOL_m)}$$

Equation 4.3.1

Where:

$LOAD_k$ = Portion of total load met by water heater k.

$LOAD_T$ = Total water heating load of system in Btu/hr.

$OUTPUT_m$ = Full load output capacity of water heater m.

VOL_m = Actual storage capacity in gallons of water heater m.

4.3.3.28 Duct Efficiency Calculation

Description: The ACM Compliance Documentation shall describe the parameters that the user must enter to describe the air distribution system when Chapter 7 and Appendix G are used in conjunction with verified duct sealing.

4.4 Optional Modeling Capabilities

The ACM Compliance Documentation shall provide detailed instructions on the documentation needed for optional capabilities, including instructions on how the ACM models the capability, which required capability will be used as the basis of the standard design for the capability, and any restrictions on the input values for the capability.

4.4.1 Optional Compliance Capabilities

The ACM Compliance Documentation shall describe how users model additions, alterations, and additions plus alterations to the existing building.

4.4.1.1 Additions Performance Compliance

Description: An addition is treated similar to a new building in the performance approach. Since both {xe "pardNew conditioned floor area"} new conditioned floor area and volume are created with an addition, all systems serving the addition will require compliance to be demonstrated. This means that either the prescriptive or performance method can be used for each stage of the addition's construction.

Addition Only

Additions that show compliance with the performance method independent of the existing building, must meet the requirements for new buildings. *Standards* {xe "pard149(A)2"} §149(a)2 states that the {xe "pardEnvelope"} *envelope* and *lighting* of the addition, and any newly installed *space conditioning* or *service water heating* system serving the addition, must meet the {xe "pardMandatory measures"} mandatory measures and the energy budget determined in the performance run.

The user must input all envelope, lighting and HVAC data associated with new conditioned space. If the HVAC zone serving the addition includes a portion of the existing building, pro-rate the capacity, fan power and cfm of the system serving the addition according to the design loads in the addition as compared to the loads in the whole zone.

If the permit is done in stages, the rules for each permit stage apply to the addition performance run. If the whole addition is included in the permit application, the rules for whole buildings apply.

Existing plus Addition

{tc "

Existing plus Addition

" \l 5} Additions may also show compliance by demonstrating that efficiency improvements to the existing building offset decreased addition performance. *Standards* §149(a)2. states that the envelope and {xe "pardLighting"} lighting of the addition, and any newly installed {xe "pardSpace conditioning"} space conditioning or service {xe "pardWater heating"} water heating system serving the addition, must meet the mandatory measures just as if it was an addition only. It also allows the

applicant to improve the energy efficiency of the existing building so that it meets the energy budget that would apply to the entire building, if the existing building was unchanged, and the addition complied on its own.

This analysis includes a calculation of the energy use of the existing building. In this approach, the following steps must be followed:

- a) Collect and document all information on the existing building before the addition and/or remodel.
- b) Analyze the energy performance of the existing building before any changes take place.
- c) Analyze the energy performance of the existing building plus the addition, including any changes to the existing building.
- d) The estimated energy use of the modified existing building plus the addition must be less than the estimated energy use of an addition that complies with the prescriptive standards and the estimated energy use of the original existing building.

When using this compliance approach, it is important to take into account all changes in fenestration, especially windows and skylights which are removed from or added to the existing house as part of the remodel. Credit may be gained in this context by insulating previously uninsulated parts of the building envelope.

It is important to note that the term "entire building" means the ensemble of all enclosed space in a building, including the space for which a permit is sought, plus all conditioned and space within the structure.

To show compliance with this approach you need to follow the instructions in the computer program's compliance supplement.

When using this compliance approach it is important to take into account all changes in the buildings features that are removed from or added to the existing building.

Documentation of the existing buildings features is required to be submitted with the permit application if this method is used.

4.4.1.2 Alterations Performance Compliance

Description: Using the performance approach for the alteration is similar to demonstrating compliance with an addition.

Alteration Only

{tc "Alteration Only

" \l 5} Altered spaces that show compliance with the {xe "pardPerformance Method"} method independent of the existing building, must meet the requirements for new buildings. *Standards {xe "pard149(B)2"} §149(b)2* states that the and {xe "pardLighting"} lighting of the alteration, and any newly installed {xe "pardSpace conditioning"} conditioning or service {xe "pardWater

heating system" } water heating system serving the alteration, must meet the {xe "pardMandatory measures"} mandatory measures and the permitted space alone shall comply with the {xe "pardEnergy budget"} energy budget determined using an alternative computer program.

If the permit is done in stages, the rules for each {xe "pardPermit stages"} permit stage apply to the alteration performance run.

If all the alterations' components, including the envelope, mechanical and lighting systems, are included in the permit application, the rules for whole buildings apply.

Existing with Alteration

{tc "

Existing with Alteration

" \1 5}Alterations may also show compliance by demonstrating that efficiency improvements to the existing building offset decreased performance of the permitted space. {xe "pardStandards 149(a)2"} Standards §149(a)2. states that the {xe "pardEnvelope"} envelope and {xe "pardLighting"} lighting of the alteration, and any newly installed {xe "pardSpace conditioning"} space conditioning or service {xe "pardWater heating"} water heating system serving the alteration, must meet the mandatory measures just as if it was an alteration only. It also allows the applicant to improve the energy efficiency of the existing building so that it meets the {xe "pardEnergy budget"} energy budget that would apply to the entire building, if the existing building was unchanged, and the permitted complied on its own. To show compliance with this approach you need to follow the instructions in the computer program's compliance supplement.

When using this compliance approach it is important to take into account all changes in the buildings features that are removed from or added to the existing building as a part of the alteration.

Documentation of the existing buildings features is required to be submitted with the permit application if this method is used.

4.4.1.3 Alternate Performance Compliance Method

Description: Any addition, alteration or repair may demonstrate compliance by meeting the applicable requirements for the entire building. Using this method, the entire building could be shown to comply in permit stages or as a whole building. The rules for new buildings, and both permit stage compliance and whole building compliance would apply.

Documentation of the existing buildings features is required to be submitted with the permit application if this method is used.

4.4.2 Optional Loads Capabilities

4.4.2.1 Conditioned Floor Areas

Description: The ACM Compliance Documentation must describe how the user determines and enters the conditioned floor area for each occupancy area and for the building as a whole. The ACM Compliance Documentation must state that the conditioned floor area for spaces within the building DO NOT include the area under

permanent floor-to-ceiling height partitions, but the conditioned floor area for the whole building includes the area under these partitions. This conforms with the Standards which define Conditioned Floor Area:

... is the floor area (in square feet) of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces of exterior walls enclosing conditioned space.

But for internal and enclosed spaces lighting power allotments for the Area Category Method are determined from floor areas:

... Where areas are bounded or separated by interior partitions, the floor space occupied by those interior partitions shall not be included in any area.

4.4.2.2 Footprint Areas

Description: The ACM Compliance Documentation must describe how to determine and describe building footprint(s). The description must include the following information.

1. All directly or indirectly conditioned volume are included in the footprint area.
2. All building interior cavities (atria and courtyards) are included in the footprint area.
3. Floors have the same footprint if:
 - a) They have identical plan views, i.e., having the same shape and area after including all building's interior cavities,
 - b) They have identical floor to ceiling distances, and
 - c) They have identical window patterns.
4. Floors having identical footprints may be modeled using Floor Multipliers or an equivalent technique. The user shall model the lowest floor having that footprint and the ACM shall duplicate these features for all floors of the building having that footprint.

4.4.2.3 Geometry of Building's Interior Cavities

Description: The ACM Compliance Documentation must describe how to model building's interior cavities such as atria and courtyards. The description must include definitions of atria and courtyards and describe the difference between them, information about when the cavity is modeled as a conditioned space and when it is modeled as outside, and how to model the partitions separating the conditioned space from the building's interior cavities.

4.4.2.4 Self Shading

Description: The ACM Compliance Documentation shall describe how the user enters parameters describing building self shading. The ACM Compliance Documentation shall describe any restrictions on the parameters. Only parts of the building that are included in the permit for which the building is being modeled are allowed to be included in the building self shading. Adjacent buildings or existing buildings may not be modeled as building self shading. These building parts that are providing shading must be a contiguous building with the conditioned area of the portion of the building that is being analyzed for compliance. Building self shading may shade either the glazing or opaque surfaces.

4.4.2.5 Lighting Controls

Description: The ACM Compliance Documentation must describe how to enter lighting controls, how to account for installed lighting and how to document the location and quantity of lighting on the appropriate forms.

4.4.2.6 Light Heat To Zone

Description: The ACM Compliance Documentation must describe how to enter the light heat that goes to the zone and to the return air, how to account for the light energy, and how to document the type, location, and quantity of lighting fixtures for which this option is being modeled on the appropriate forms.

4.4.3 Optional Systems & Plant Capabilities

4.4.3.1 System Areas

Description: The ACM Compliance Documentation must describe the number of system areas (a minimum of fifteen) that the ACM is capable of modeling. System areas may only be combined when there are more than fifteen (15) system areas in a proposed building design.

The ACM Compliance Documentation must explain the characteristics that will lead to system areas being similar, so they may be combined into one system area for modeling purposes, and the characteristics that will lead to the system areas being dissimilar. An example of similar system areas may be central core areas on multiple floors of a multi-story building. An example of dissimilar system areas may be a perimeter area on one facade of a building, part of which includes glazing and part of which has no glazing. The conditions in these two areas are sufficiently dissimilar that the areas should be treated as two system areas (if they

are independently controlled) even though they are on the same floor and facing the same orientation.

4.4.3.2 Thermal Zones

Description: ACMs shall explain that thermal zoning is performed by the program during the compliance run and no user input is required.

4.4.3.3 Optional Systems

Description: The ACM Compliance Documentation shall include descriptions of all the optional systems that the ACM is capable of modeling. Optional systems that are allowed are described in Section 3.5.2. The ACM Compliance Documentation shall provide a detailed description of each optional system that is modeled, shall describe the system type that is used as the comparative standard design as described for minimum system capabilities, and will describe any restrictions on the capabilities of each optional system.

The ACM Compliance Documentation shall require the user of the ACM to provide manufacturers data, plans and specifications to document the assumptions used for each optional system.

4.5 Vendor Defined Optional Capabilities

Optional capabilities that are not described in this manual may be proposed by ACM vendors. These Capabilities may be approved by the Commission when sufficient documentation is provided to justify that the capability achieves the estimated energy savings. Once the Commission has accepted a vendor defined optional capability, the ACM Compliance Documentation must include a description of how the user enters the appropriate parameters for the capability, a description of the documentation that must be provided when using the capability, and a description of any restrictions that must be applied when using the capability.

4.6 Compliance Forms

A chapter or section must focus on how standard compliance forms are automatically generated and how to get diagnostic output when a building fails to comply (since compliance forms cannot be generated when a building fails to comply.) Alternative Calculation Methods (ACMs) must print out the standard compliance forms with essentially the same format and layout as those in Chapter 2 or the Appendices. Mention should be made of:

- The requirement to document Tailored Lighting Allotments with lighting plans and prescriptive LTG-3 forms for each HVAC zone;
- The requirement to document Tailored Ventilation and/or Process Loads;
- The requirement to complete other forms for submittal (e.g., ENV-3) when applicable;

- The requirement to document the zoning of the building if the zoning is not evident on the plans; and,
- The requirement to document Exceptional Conditions, Special Features and Remarks, on the Certificate of Compliance (PERF-1) when applicable.

At least one sample of each compliance form must be included. It is recommended, but not required, that the ACM Compliance Documentation contain several sample variations of each compliance form as needed to illustrate different compliance scenarios and input types (see Appendices below).

4.7 Appendices

Appendices may be an appropriate way to handle sources of information that are not crucial in explaining the basic functioning of the program for compliance. For example:

- An appendix may contain variations of compliance forms as described above.
- An appendix may include a series of construction assembly (ENV-3) forms to aid the ACM user.
- An appendix may reprint important sections of the *Nonresidential Manual* or this manual that are crucial to modeling buildings correctly for compliance with the ACM.